Letters to the Editor

How to approach land use in LCIA or, how to avoid the Cinderella effect?

Comments on 'Key Elements in a Framework for Land Use Impact Assessment Within LCA',

by Llorenç Milà i Canals, Christian Bauer, Jochen Depestele, Alain Dubreuil, Ruth Freiermuth Knuchel, Gérard Gaillard, Ottar Michelsen, Ruedi Müller-Wenk, Bernt Rydgren (published in OnlineFirst on June 6th, 2006, to be accessed at DOI: http://dx.doi.org/10.1065/lca2006.05.250)

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Introduction

I do fully agree that land use is a very important threat to a number of life support functions and to biodiversity. It may well put in the shade the impacts on biodiversity due to toxic substances, which are good for about one half of methodological efforts in LCIA, to make a guess. It is therefore fully legitimate that this issue is now really being taken up in the LCA community, and I am glad that a consistent and very well readable article is being published in this issue.

However, this general support does not imply that I do agree with the main approach chosen and with the resulting outcomes. In order to stimulate discussion about this very important issue I draw here an alternative route on how to deal with land use in LCIA. Let it be clear that this is not something final, it intends to promote some rethinking of the efforts being made.

I have two main comments on the given article. The first concerns the narrowing down to just three main types of impact related to land use: to biodiversity (existence value), to biotic production (including soil fertility and the use value of biodiversity), and to ecological soil quality (including other life support functions). The second concerns the lack of a critical analysis whether the selected impacts do fit in the methodological structure of LCA.

My preferred approach of the subject 'Land use and LCA' would be the following:

- identification of (possibly) all relevant aspects connected with land use
- identification of conditions for a good fit of aspects in LCA
- identification of those aspects of land use which do fit well in LCA, in combination with suggestion how to cover these in LCI and LCIA categories
- identification of those aspects of land use which are problematic to include in LCA
- survey of other possibilities to include the latter aspects in environmental analysis.

I use here the broader term 'aspects' compared to impacts, because I also will include elements of the inventory phase. This seems adequate, because many aspects of land use can be identified at that level, without sufficient knowledge being available on how to translate them in terms of LCIA categories. Further, I will also use the term 'land use' in a broader scope, not only pertaining to impacts to ecosystems but also to marine ecosystems, for which comparable reasoning holds.

1 Relevant Aspects of Land Use

The article lacks a definition of land use impacts. I suggest the following: land use impacts are impacts, which are neither caused by inputs into nor outputs from the product system; rather they are related to physical (in contrast to chemical) changes in the environment. It is a broad term, and I agree with the authors that land use includes a number of aspects, which can be well incorporated in traditional LCIA categories. Still I think that when entering this new field one should rather start with a broad overview of aspects, and then select those aspects, which appear to have escaped from analysis so far. I distinguish between activities in the LCI phase, midpoint impacts, impacts on life support functions and impacts at damage level.

a. Activities in LCI phase

- terracing of croplands, removal of terraces
- restoration of eroded fields
- changes in the groundwater table (in contrast to water extraction)
- ploughing, removal of weed vegetation
- conservation of patches of wild vegetation
- others

b. Midpoint impacts

- surface area needed for crops
- changes in organic carbon content of soil
- release of greenhouse gases from the soil to the air due to changes in groundwater table
- carbon sequestration
- release nutrients and acidifying substances from the soil to the groundwater due to changes in groundwater table or to logging of trees
- salinization due to irrigation in combination of evaporation of soil water
- others

c. Life support impacts
- soil erosion
- soil fertility loss
- disturbance of nutrients cycling
- disturbance of hydrology
- others

d. Damage impacts
- habitat loss
- impacts on biodiversity (existence value)
- impacts on biodiversity (production value)
- others

2 Identification of Conditions for a Good Fit of Aspects in LCA

LCA has a very specific modeling structure, requiring quantification in relation to a functional unit, and thus sets limits what type of aspects can be incorporated. I see the following main points:

- Quantitative character. I have increasing doubts about the possibility to flag qualitative impacts, as suggested in the article (and also suggested by myself in earlier publications). Such footnotes usually vanish during the process and appear not to play a significant role in decision making practice.
- Clear relation to a functional unit. This implies a strong preference for aspects with a flow character, either in or out of the product system.
- Generic regarding space. This is due to the life cycle character, potentially implying impacts in all regions of the world. A focus on regions within a global set-up is in development.
- Steady state analysis. LCA is primarily a steady state tool, due to the fact that all processes do have different time characteristics.

3 Which Aspects Do Fit in the LCA Structure?

First of all, we can be sure that the establishment of a flow chart of processes with their inputs and outputs is an element of LCA, which can largely contribute to the question how to deal with land use impacts.

For LCIA I think that releases of substances from the soil to the ground water or to the air, due to physical changes in the environment (such as the cutting of trees or the lowering of the groundwater table) can be included in existing impact categories. The points is that there is no clear relationship with the emission of substances from the processes of the product system.

Salinization of the soil can be linked to the input of salt via the irrigation water and may well become an additional traditional category, although also strongly dependent on evaporation and undue irrigation practice.

Also well fitting is the surface area needed for crops. Although not actually flowing, this issue can well be accommodated within the traditional LCIA structure: x ha per y kg of crop per year. This measure is already becoming broadly in use, as well in agriculture, in forestry and in fisheries.

4 Which Aspects are Problematic to Include in the LCA Structure?

The following aspects are problematic to include in the structure of LCA. The main point is that they do not have a flow character with clear input or output characteristics. But in addition as problem can be that they have a local focus or a discrete time behavior.

- physical management measures (terracing, ploughing, weeding)
- soil erosion (or stabilization)
- loss (or increase) of soil fertility (resp., in organic carbon content and soil fauna)
- impacts on nutrient cycling
- impacts on hydrology
- one-time habitat loss (or increase)
- loss (or increase) of biodiversity

Precisely here lies the core of the article. Surely, some remarks are made about the required modeling in order to realize a fit with the LCA modeling structure. For a more detailed analysis of what in principle can be done for inclusion of these issues in the LCA framework, see Guinée et al. 2006. I do not exclude that indeed real progress can be achieved for some of these aspects, thus extending LCIA in a science based way. But there are clear limitations. Let me take the loss of biodiversity as an example.

First of all, metrics such as the potentially disappearing fraction of species (PDF) or the potentially affected fraction of species (PAF) are used as indicators for changes biodiversity. Although there are uncertainties regarding the sensitivity of species, this seems to be based on sound science. But these indicators reflect only generic species characteristics. They enable to extend toxicity categories to a damage level, and do not deal with local biodiversity. So this is not an example where "the clear borders between LCA and EIA become somewhat less distinct" (see introduction of the article, 3d paragraph), suggesting more room for site specific and time dependent impacts in LCA. (See also the figures of the article, focusing on quality changes at the local level).

At the local level a distinction must be made between one-time events, like the cutting of a forest, and biodiversity going in hand with activities like resource production. Let me start with the first. Apart from the fact that changes in local biodiversity are in contrast to the predominantly global or regional character of LCA, we observe that typically such transformations are based on mere assumptions regarding the temporal aspect. In order to make the disappearance of a forest area fit into LCA, the habitat loss is allocated to the production of the newly formed meadow- or cropland over a period of 100 years, but that has no real ground.

Biodiversity concomitant with activities like resource production more resembles the surface area aspect of land use. Here I see the best potentials for inclusion of biodiversity in LCA. It requires a generic weighting scheme of species assemblages of different types of land use, like in a crude form put forward by IUCN/WWF/UNEP (1991) and later elaborated by Koellner for agriculture in Switzerland (2000). I think that this approach earns more attention.

Comparable comments hold for the other aspects of the problem group. Sometimes specific issues can be taken along, like groundwater extraction in contrast to other impacts on the hydrology, like the lowering or stabilization of the groundwater table. It needs careful analysis of what is possible and useful and what not. My general fear is, however, that exercises to make this group of impacts fit into LCA, will produce results which are so far removed from what is happening in practice, that they will have no influence on actual decision making.

5 Other Approaches

Although outside the scope of LCA modeling, the latter aspects may still be crucial from an environmental point of view. Are there perhaps other possibilities, which still do fit in a life cycle perspective? I think there are. Not for formal chain analysis, for which LCA is the dominant tool, but for chain (or life cycle) management. That is, the collection of information about a given stage of the value chain, which is communicated to other stages. More specifically, information about land use impacts connected with the extraction of natural resources can be communicated to, say, manufacturing industries, retailers or consumers. Both analytical tools and procedural tools may play a role here (cp. Wrisberg and Udo de Haes 2002).

On the one hand, local modeling tools may provide useful information. For toxic impacts, local Environmental Risk Assessment may provide useful information; or ecological modeling for impacts on local biodiversity.

On the other hand one may make use of procedural tools, like the certification of the extraction of natural resources, and the subsequent Type I or Type III labeling of the resulting intermediate and final products (also called 'Chain of Custody Certification'). For the forestry sector, certification of sustainable wood extraction is done under authority of the Forest Stewardship Council (FSC) (www.fsc.org). Likewise, for the fisheries sector, certification of sustainable fishery practices is done under the authority of the Marine Stewardship Council (MSC) (www.msc.org). For mining activities, first steps towards more sustainable management are explored in the recent Sustainable Development Framework, developed under authority of the International Council on Mining and Metals (ICMM) (www.icmm.com). For agriculture, although not dealing with natural resources but still with land use, there is the well-organized certification of organic farming; but also new initiatives are developing like the Sustainable Agriculture Initiative Platform (www.saiplatform.org), defining criteria and indicators.

My main point is that the above certification procedures are much better coined at the identification and regulation of relevant aspects of land use, connected with the extraction or production of resources, than LCA. Just to take the fisheries as example: mesh width, used gear, protected areas, closed seasons, and measures against by-catch can all easily be included in the requirements. Inclusion of these aspects in LCIA would be impossible, not the least because most of the relevant aspects are identified in terms of physical measures, and not in terms of flows of substances and their impacts.

6 Conclusions

I draw the following conclusions with respect to the steps indicated in the introduction. Quite a number of environmental aspects are related to land use, both relevant for the LCI and LCIA phases. When compared with criteria for the fit in the LCA modeling structure, all aspects connected with the flows of substances resulting from physical measures, do in principle fit well, although the link to LCI interventions may be problematic. These aspects can be taken along via the traditional impact categories, or new categories shaped in the same way. Also the surface area needed for crop production (or other societal activities) can be well accommodated by LCA, as an impact category in itself.

However, aspects that deal with physical management measures, with life support functions, and with biodiversity, are problematic to include in LCA. Careful analysis may show some important exceptions for parts of these types of impact. Examples include water extraction and biodiversity concomitant with land occupation by different activities. From the viewpoint of practical application my general fear is that it will not be useful to squeeze non-fitting aspects mathematically into the LCA modelling framework. I am afraid that a Cinderella-option of squeezing of non-fitting impacts into LCA, will not really influence decision making, neither as it did in the fairy tale.

In contrast, I suggest that alternative options to address these impacts in a life cycle management framework. Examples concern local ecological or ecotoxicological modeling, with its results communicated along the value chain; and sustainability certification of resource extraction, connected with labelling of the forthcoming products, as procedural tool. An open point is then how the results of an LCA study and the additional information should best be combined.

References

Guinée JB, Van Oers L, De Koning A and Tamis W (2006): Life cycle approaches for Conservation Agriculture. Research commissioned by Syngenta Crop Protection AG, Basel. CML report 171, CML, Leiden. Can be downloaded from: <http://www.leidenuniv.nl/cml/ssp/index.html>

IUCN/WWF/UNEP (World Conservation Union/Worldwide Fund for Nature/United Nations Environment Programme) (1991): Caring for the earth. A strategy for sustainable living. IUCN, Gland, Switzerland

Koellner T (2000): Species-pool effect potentials (SPEP) as a yardstick to evaluate land use impacts on biodiversity. J Cleaner Production 8, 293–312

Wrisberg N, Udo de Haes HA (eds) (2002): Analytical tools for environmental design and management in a systems perspective. Kluwer Academic Publishers, Dordrecht/Boston/London, 275 pp